

HIGH RESOLUTION DYNAMICS LIMB SOUNDER

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Subject/Title: **HIRDLS Instrument Mass Properties Report**

Description/Summary/Contents:

During the instrument's assembly, predictions were made about its mass and center of mass (center of gravity). Later, measurements were made of the instrument's total mass, and center of mass along the X-axis and the Y-axis. Since the X-axis and Y-axis predictions came so close to their measured values, we feel justified in determining the Z-axis value by analysis rather than measuring it (as allowed by waiver CCR No. 424-12-21-068).

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HIRDLS Mass Properties Report

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Log of Changes

Rev.	Date	Section	Change Description
N/C	02-08-01	All	Initial release.

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1.0 INTRODUCTION

In March of 2002, predictions were made for the mass properties of the HIRDLS instrument (1). These predictions were augmented by the use of the finite element model of the HIRDLS Instrument. When considering the predictions, it is helpful to understand how the I-DEAS software determines the mass properties of the mass model. First, the mass, shape, size, location, etc. are entered as individual components only to represent that portion of the HIRDLS instrument. The program then assembles these elements together to construct a three-dimensional, finite-element-model of this instrument. With the information entered, the program can quickly perform the mathematical calculations to produce a mass, the center of gravity, and the moments of inertia, and which can be for the point of reference of choice.

In July of 2002, the fully assembled instrument was measured for the HIRDLS Instrument weight and its center of mass, but only along the X- and Y-axes (see TR-LOC-1039 for details). To accomplish this, the instrument was placed upon the three load cells. Manipulation of the output from the three cells and adjustment for various environmental factors has revealed the mass properties of the HIRDLS Instrument, such as the total mass. Further manipulation of the output from the three cells produced the calculation of the X- and Y-axis center of mass. For the sake of accuracy, the total instrument mass was again measured on August 12, 2002.

As a preliminary result, the measurements closely match the predictions. Yet, the analysis of the Z-axis center of mass has been refined using the measurements of the X and Y center of mass axes.

2.0 TECHNICAL DISCUSSION

2.1 MASS

The HIRDLS instrument has been allocated 186.00 kg and, according to the Unique Instrument Interface Document (UIID), may have a mass of up to 200 kg. After having weighed most of the individual components of the instrument and estimating the amount of cabling required, the total mass was predicted to be 179.38 kg. This prediction came quite close to the actual measurement. The mass of the instrument was measured to be

179.08 kg. The HIRDLS instrument is well within its weight limits. The GIRD requirement 3.3.1 Instrument Mass Allocation, which states “The Instrument mass shall be less than or equal to that allocated in the UIID”, has been met.

The uncertainty in the mass measurement is calculated to be 0.10kg. The GIRD requirement 3.3.2 Instrument Mass Documentation states, “The mass of the Instrument ... shall be measured to +/- 0.1kg”. This requirement has been met.

2.2 CENTER OF MASS (CENTER OF GRAVITY)

The center of mass of the HIRDLS instrument is summarized in Table 1. Figures are given for both the Space Craft Reference Frame (SCRF) and the Instrument Coordinate Reference Frame (IRCF). The SCRF is the one used by TRW, where everything is defined according to its position on the spacecraft. The IRCF is the one most commonly use by the science team, where everything is defined in relation to the center of the scan mirror.

Table 1: Center of Mass (mm)

Axis	SCRF		IRCF	
	Predicted	Measured	Predicted	Measured
X	3871.1 +/- 6.4	3887.22 +/- 3.48	985.6 +/- 6.4	1001.72 +/- 3.48
Y	519.6 +/- 6.4	538.46 +/- 2.51	831.0 +/- 6.4	849.86 +/- 2.51
Z	366.6 +/- 6.4	367.6*	527.0 +/- 6.4	528.0*

* These figures were determined by analysis as allowed by waiver

GIRD requirement 3.3.3.2 Center of Mass Measurement and Documentation states, “The launch and on-orbit center of mass of each instrument component shall be measured and reported to +/- 5 mm, referenced to the instrument coordinate axes as documented on the ICD”. The measurements requested are the IRCF measurements above. The X and Y uncertainties are 3.48mm and 2.51mm respectively, well within the GIRD requirement. There was no appreciable difference between the launch and on-orbit centers of mass.

The Z-axis center of mass was not actually measured due to lack of equipment and concerns about potential damage to the instrument. Waiver CCR No. 424-12-21-068 allows us to determine the Z-axis center of mass by analysis. Again it should be noted that the predicted values for total mass, X-axis cm and Y-axis cm come very close to the measured values. This gives us confidence that our Z-axis center of mass figures, shown above are reasonably accurate.

CONCLUSION

Our mass properties measurements and analyses are now complete. The results are summarized in Table 2, below. All GIRD requirements, section 3.3.1 through 3.3.3.2 have been met except the Z-axis center of mass measurement, which has been waived.

Table 2: Mass Properties Summary

Parameter	SCRF	IRCF
Mass	179.08+/-0.10 kg (393.12+/-0.22lbs)	
X-axis CM	3887.22 +/-3.48mm (153.0 +/-0.1 in)	1001.72 +/- 3.48 (39.4 +/-0.1 in)
Y-Axis CM	538.46 +/- 2.51 mm (21.2 +/-0.1 in)	849.86 +/- 2.51 mm (33.5 +/-0.1 in)
Z-Axis CM	367.6* mm (14.5* in)	528.0* mm (20.8* in)

* These figures were determined by analysis as allowed by waiver

REFERENCE

- 1) TR-LOC-942, HIRDLS Instrument Mass and CG Predictions, T. Curry, 02-03-06
- 2) TR-LOC-1039, HIRDLS Instrument Mass and CG Measurements, B. Biggs 02-07-12
- 3) D26477, Rev. B, Interface Control Document (HIRDLS/EOS), TRW, 00-07-31
- 4) C326375, Mechanical Interface Drawing EOS-AURA, TRW, 00-07-31
- 5) GSFC 424-28-21-13 HIRDLS Instrument Technical Specification 02-02